[preparing] providing a cleaning gas in the reactor furnace to clean up the surface of the substrate between the step of diffusing the ion implanted region and the step of growing the epitaxial layer.--

--8. (Amended) The process for fabricating the semiconductor device as set forth in claim 4, wherein the cleaning gas comprises [is consist of] H_2 gas.--

Cancel Claim 2

REMARKS

By this amendment a minor informality in the specification has been corrected and claims 1, 4 and 8 have been revised to eliminate indefiniteness and to distinguish clearly from the prior art, while claim 2 has been canceled.

With respect to the rejection of claim 2, which has been canceled, the subject matter of that claim has been incorporated into claim 1 with revised terminology which avoids the basis for the rejection. In response to the Examiner's comments, moreover, it should be noted that, as shown in Figs. 12 and 13 and illustrated graphically in Fig. 14 and described at page 10, line 6 to page 11, line 10 of the specification, the buried impurity layer is implanted beneath the surface of the substrate, and not at the surface and the diffusion of the buried layer together with the growth of the epitaxial layer on the surface are controlled so that the buried layer does not diffuse sufficiently to reach the

surface of the substrate. Consequently, the subject matter of claim 2, to the extent incorporated in claim 1, is operative and has utility.

Moreover, the Examiner's speculation that some ions might be at the surface of the substrate prior to the activating and diffusing step has nothing to do with the requirement that the buried region 13 is formed below the surface of the substrate and does not grow sufficiently to reach the surface of the substrate. The speculation that one or more ions might possibly reside at the surface of the substrate prior to the activating and diffusing step does not affect the location of the buried region, which is below the surface, or the fact that region does not diffuse sufficiently to reach the surface, as required by the claims.

Reconsideration and withdrawal of the rejection of claims 1 and 3-9 as being unpatentable over the Yoshida et al Patent No. 4,295,898 is respectfully requested. Claim 1, the only independent claim, is directed to a process for fabricating a semiconductor device having a buried layer and it requires implanting an ion impurity region below a surface where a buried layer is to be formed in a substrate placing the substrate in a reactor furnace, providing a non-oxidizing atmosphere inside the reactor furnace, and annealing the substrate to activate and diffuse the implanted impurity ion region while increasing the internal temperature of the reactor furnace up to a first temperature and, before the implanted impurity ion region expands sufficiently to reach the surface of the substrate, changing the internal temperature of the reactor furnace from the first temperature to a second temperature at which an epitaxial crystal starts to grow on the

surface, and introducing an epitaxial growth gas into the reactor furnace to cause an epitaxial layer to grow on the surface of the substrate.

With this arrangement as described, for example, at pages 13 and 14 of the specification, an implanted ion region beneath the surface of the substrate is produced in such a way that there is no chance that crystal defects are caused in the substrate surface and no autodoping of the epitaxial layer is caused. Therefore, there is less chance of forming crystal defects in the epitaxial growing process.

No such method is disclosed and is suggested by the Yoshida et al Patent which was relied upon in support of the rejection. In Yoshida et al, as clearly described at columns 3 and 4 and illustrated in Figs. 1-5, an implanted ion region is produced at the surface of a substrate and is caused to grow while it is at the surface and before any epitaxial layer is produced. Thereafter, an epitaxial layer is produced on the surface in contact with the implanted ion region, thereby potentially leading to autodoping and crystal defects in the epitaxial layer.

Thus, Yoshida et al. do not disclose or suggest the requirements of the claims that an impurity ion region be implanted below a surface of the substrate and annealing the substrate to activate and diffuse the implanted ion impurity region but, before the ion implanted region beneath the surface of the substrate expands sufficiently to reach the surface of the substrate an epitaxial layer is grown on the surface by shifting the internal temperature and introducing an epitaxial growth gas into the reactor furnace. Moreover, there is no suggestion anywhere in Yoshida et al that the process of implanting ions at the

surface of the substrate and causing them to grow both before and during application of an epitaxial layer on the surface should be completely discarded and replaced by the process of the present invention. Accordingly, no person skilled in the art would be led to completely revise the Yoshida et al procedure to satisfy the requirements of the claims.

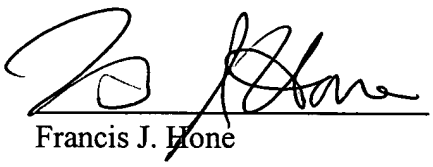
In this regard, the Examiner's comments have been noted but it should be observed that the "buried region" formed in Yoshida et al. is not beneath the surface of the substrate but, instead, is at the surface and becomes buried only by reason of the addition of the epitaxial layer whereas, in the present invention, the buried implanted ion region must be beneath the surface and remain beneath the surface during the diffusion step and while an epitaxial layer is being produced. Accordingly, the claims as amended are clearly patentable over the Yoshida et al. disclosure and should be allowed.

In response to the objection to the drawings, appended hereto are revised drawing sheets containing Figs. 6-9 and Figs. 14-16, which have been enlarged for legibility. Upon allowance of the application, new drawings corresponding to the attached figures will be submitted.

In view of the foregoing, this application is now believed to be in condition for formal allowance. Prompt and favorable action is respectfully requested.

Date: November 29, 2000

Respectfully submitted,



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Attachments:

Proposed revisions of Figs. 6-9 and 14-16.

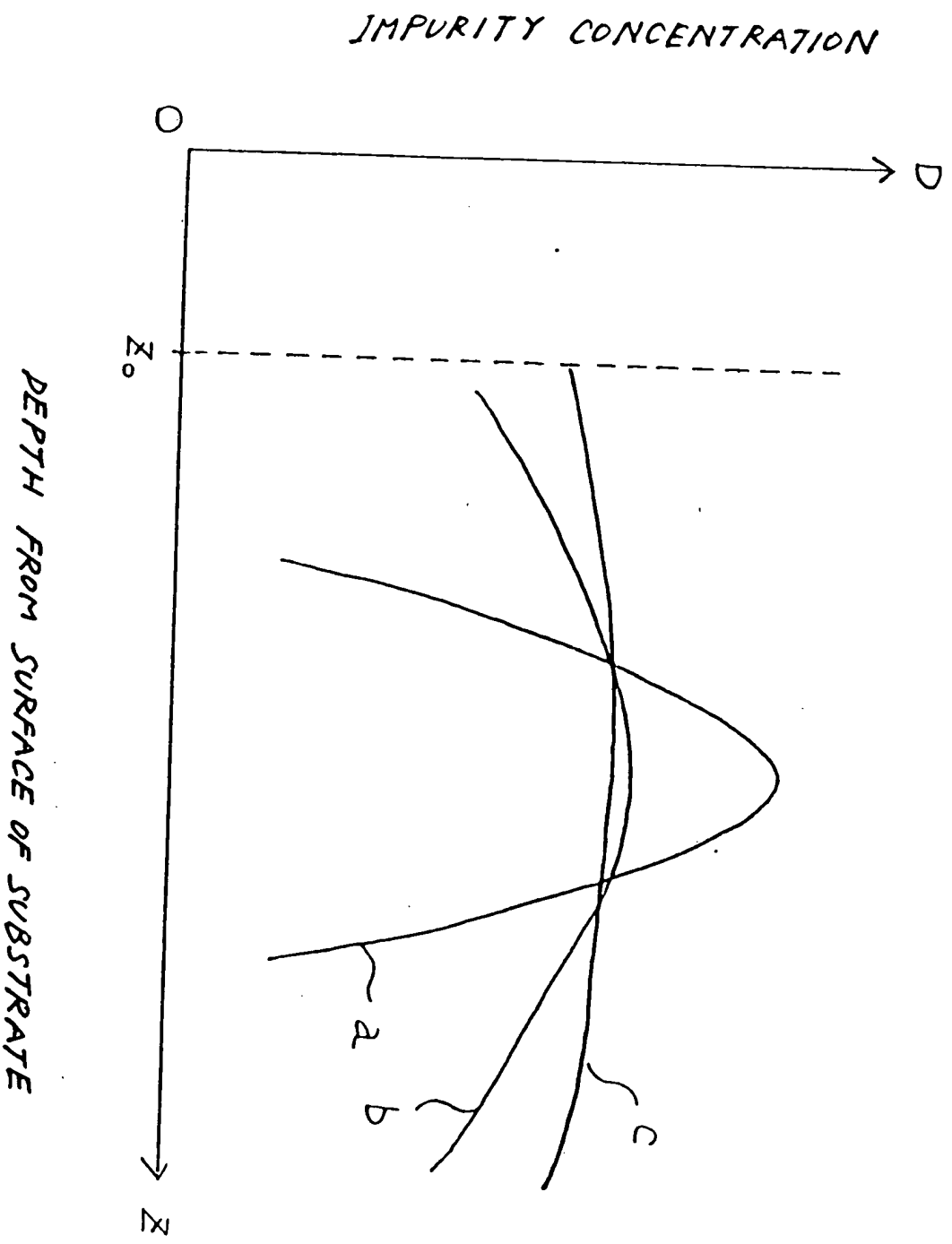

IMPURITY CONCENTRATION
O
D
Z_o
DEPTH FROM SURFACE OF SUBSTRATE
Z
a
b
c

Fig. 6

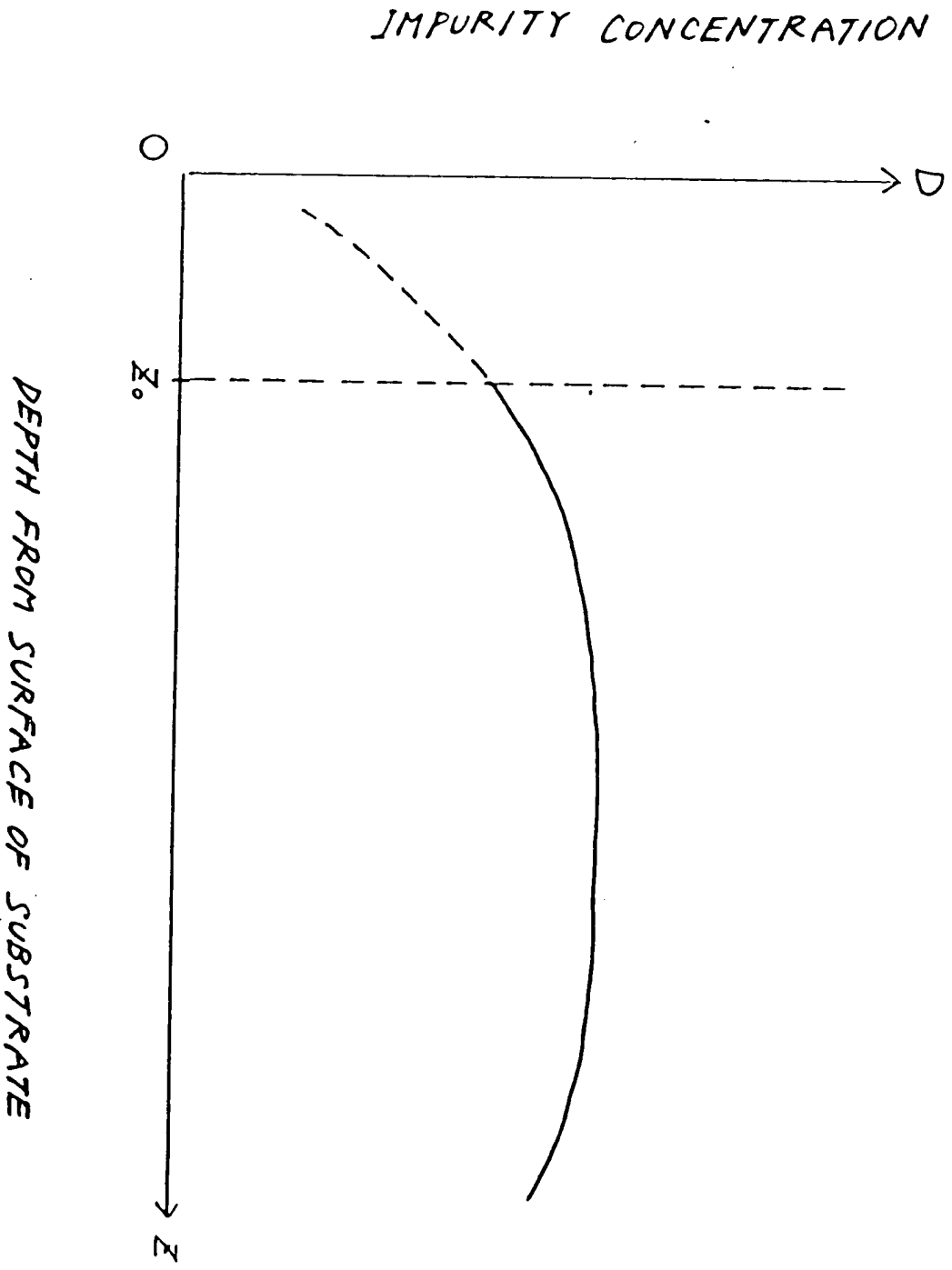

IMPURITY CONCENTRATION
O
D
Z₀
Z
DEPTH FROM SURFACE OF SUBSTRATE

Fig. 7

Fig. 8

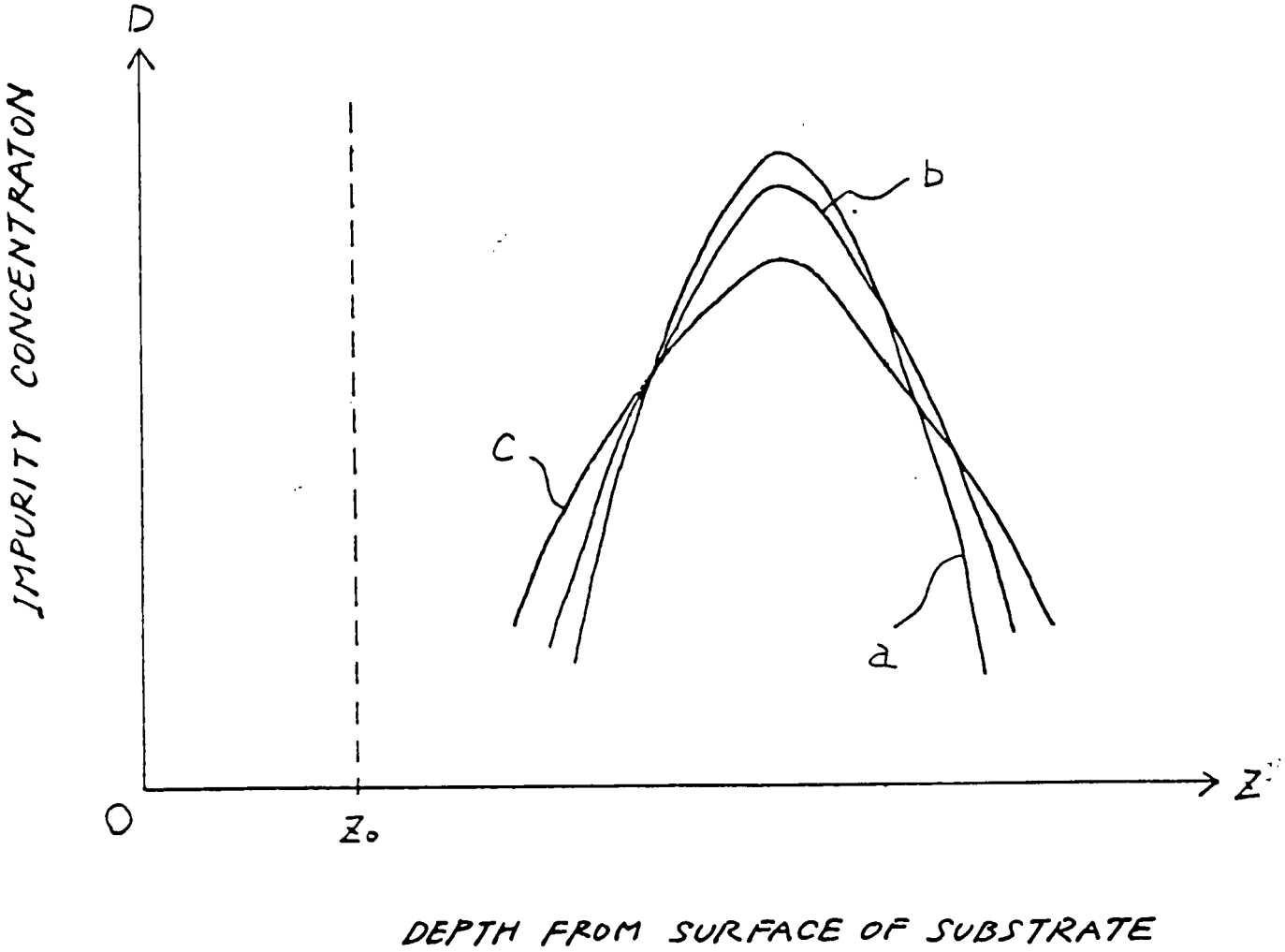

D
IMPURITY CONCENTRATION
b
C
a
O
Z₀
Z
DEPTH FROM SURFACE OF SUBSTRATE

Fig. 9

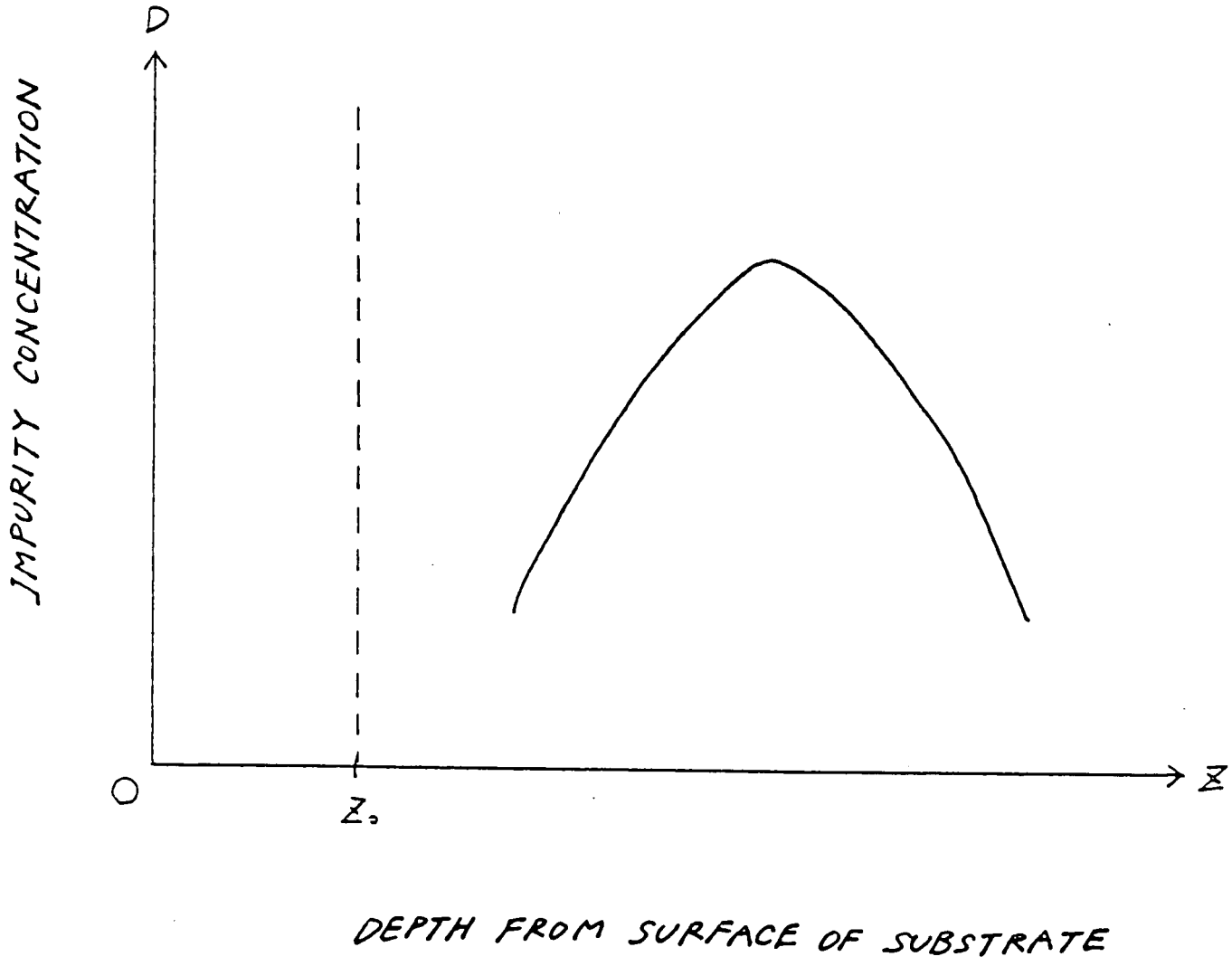

D
IMPURITY CONCENTRATION
O
Z₀
Z
DEPTH FROM SURFACE OF SUBSTRATE

Fig. 14

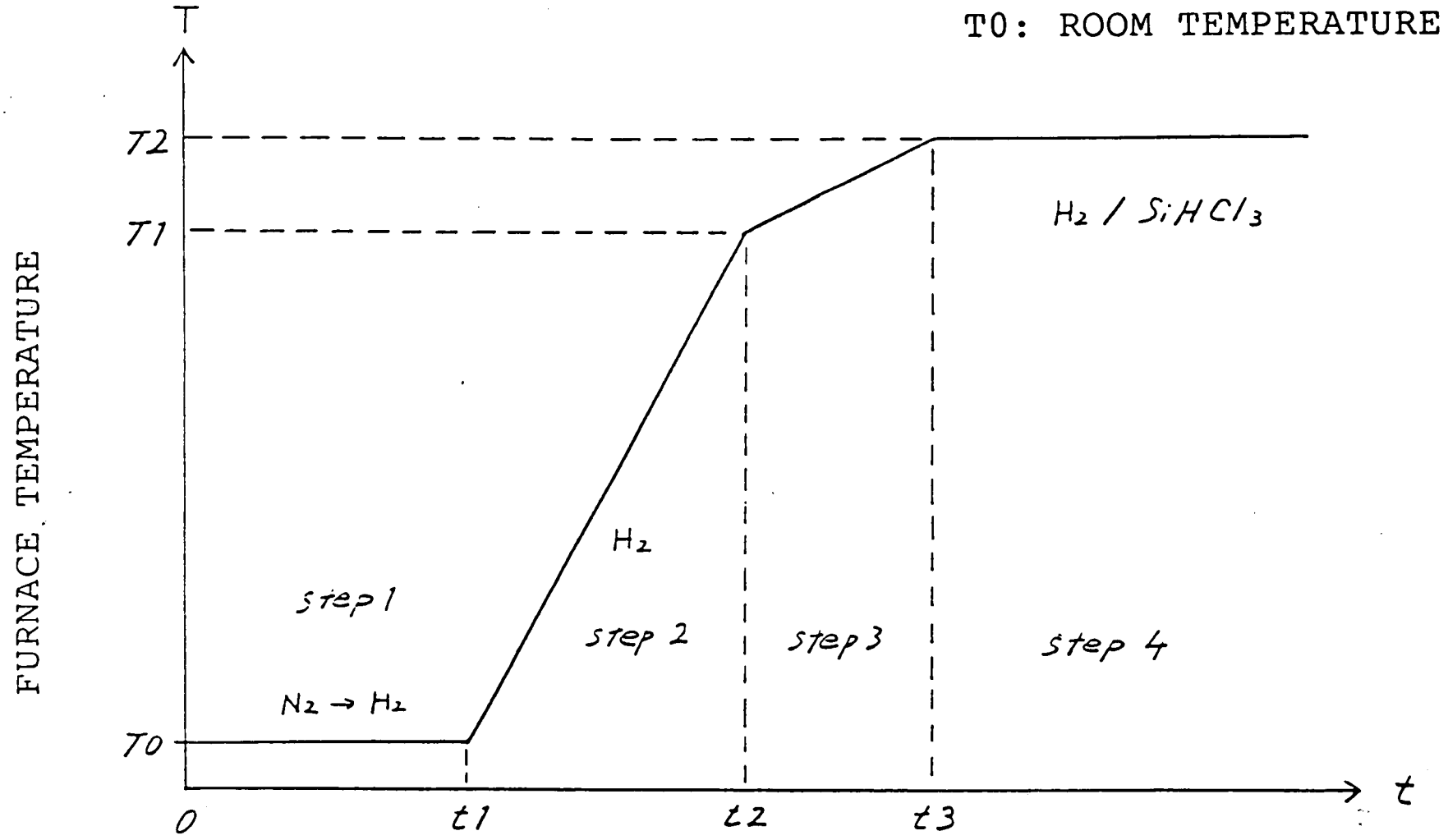

T
T0: ROOM TEMPERATURE
FURNACE TEMPERATURE
T2
T1
T0
H2 / SiHCl3
H2
step 1
step 2
step 3
step 4
N2 → H2
0
t1
t2
t3
t

Fig. 15

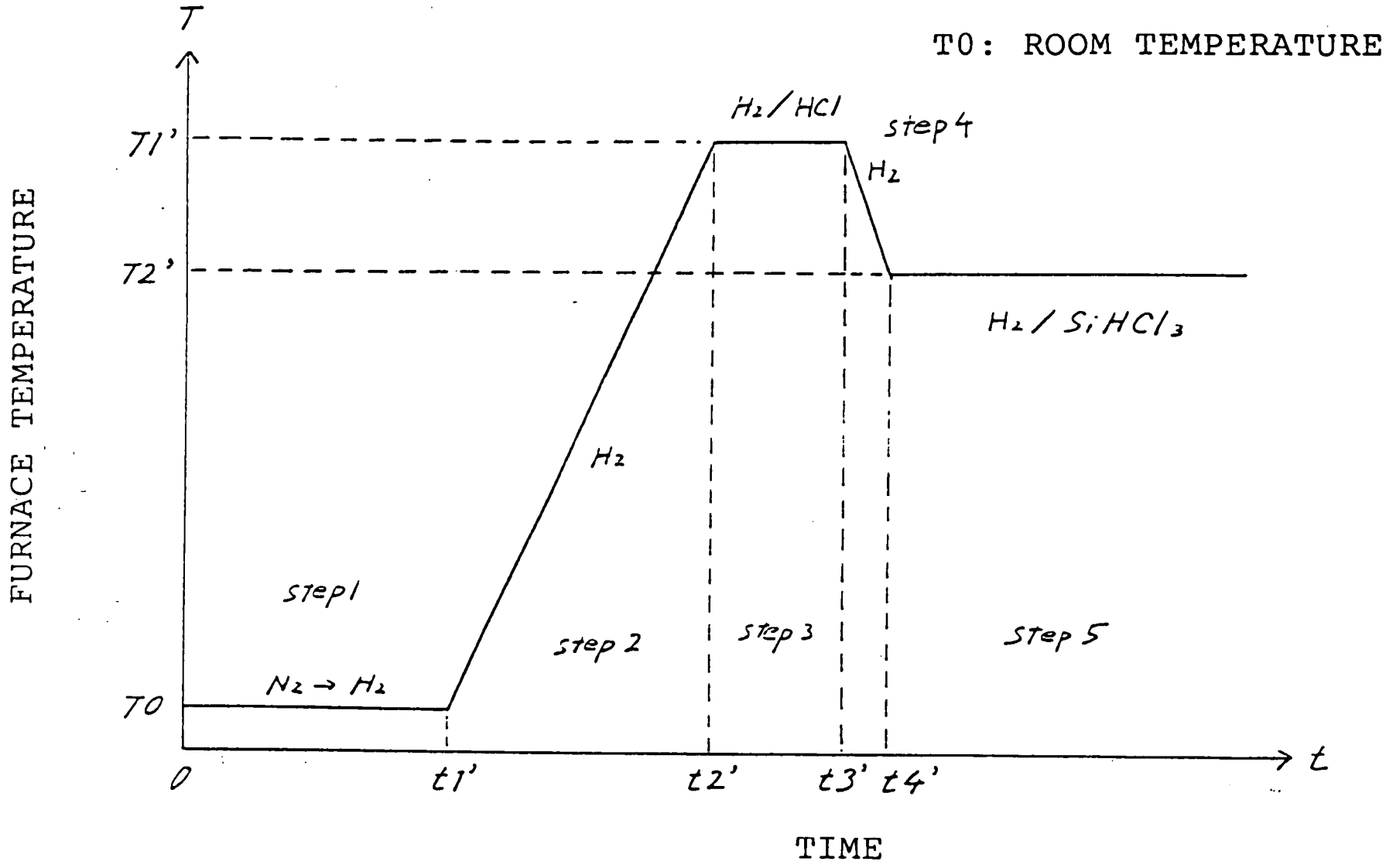
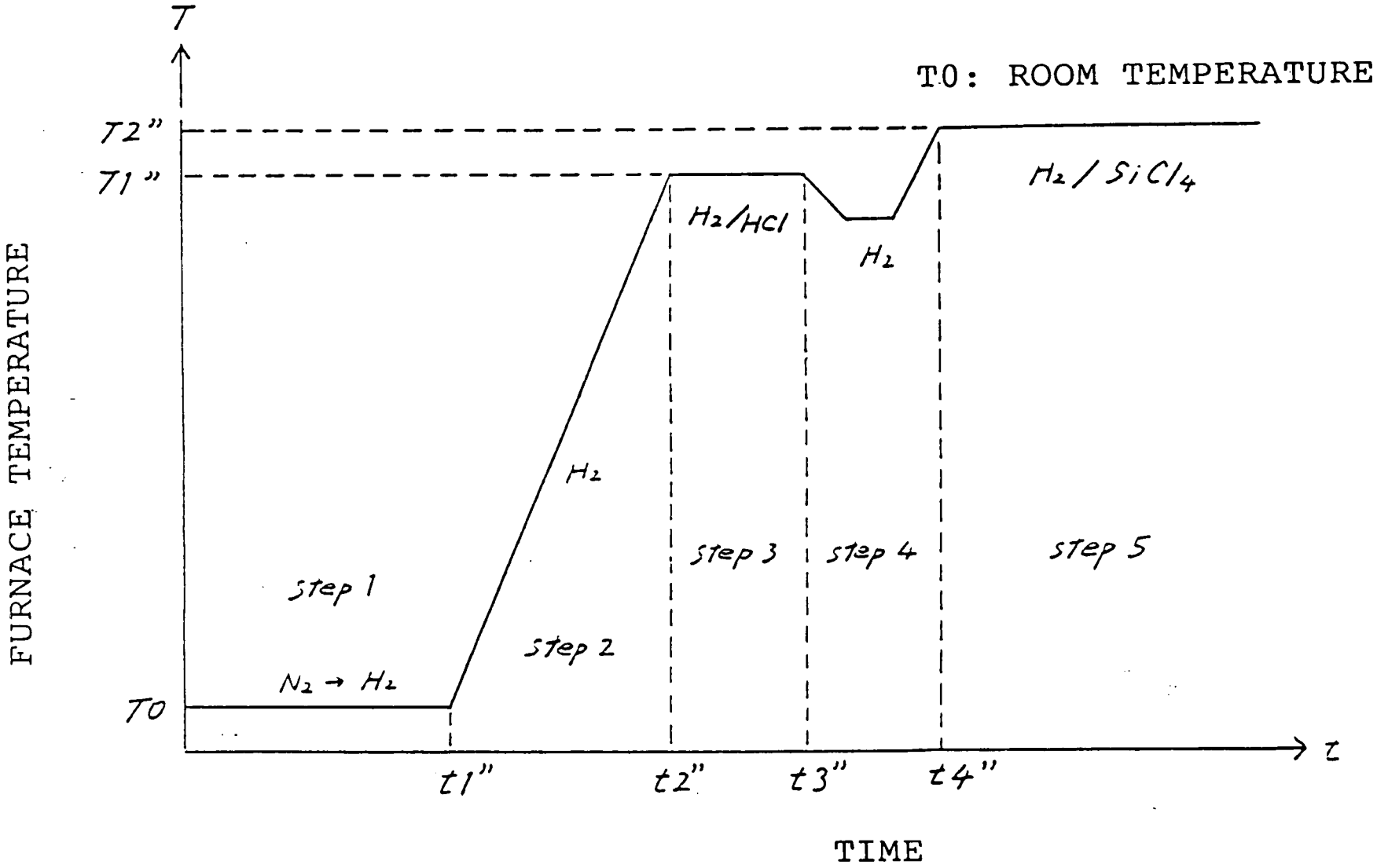

T
T0: ROOM TEMPERATURE
T1'
T2'
T0
H2 / HCl
step 4
H2
H2 / SiHCl3
H2
step 1
step 2
step 3
step 5
N2 → H2
0
t1'
t2'
t3'
t4'
t
FURNACE TEMPERATURE
TIME

Fig. 16


T
T0: ROOM TEMPERATURE
T2"
T1"
H2/SiCl4
H2/HCl
H2
H2
step 1
step 2
step 3
step 4
step 5
N2 → H2
T0
t
t1"
t2"
t3"
t4"
FURNACE TEMPERATURE
TIME